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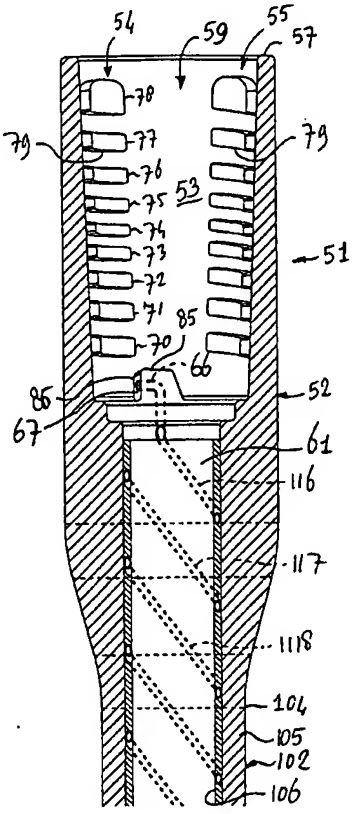
(54) Title: PIPE COUPLING AND PIPE SECTION WITH AUXILIARY CONNECTIONS

(57) Abstract

A pipe coupling for a pipe string extending in a subterranean bore hole has a pair of coupling members (1, 51; 201, 251; 401, 451) including thread portions for generating an axial force if the coupling members (1, 51; 201, 251; 401, 451) are mutually twisted in make–up sense. The coupling members (1, 51; 201, 251; 401, 451) also include auxiliary connecting members (16, 66; 216, 266; 416, 466) for connecting auxiliary transport lines (116, 117, 118; 316). Since the coupling members (1, 51; 201, 251; 401, 451) include twist limiting abutments (35, 85; 435, 485) for limiting mutual rotation of the coupling members (1, 51; 201, 251; 401, 451) in the make–up sense beyond a coupled configuration and the auxiliary connecting members (16, 66; 216, 266; 416, 466) communicating in the coupled condition are located exclusively in limited circumferential segments of the coupling members (1, 51; 201, 251; 401, 451), a reliable connection between the connecting members (16, 66; 216, 266; 416, 466) is obtained which occupies only a small cross–section of the coupling.



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TITLE: Pipe coupling and pipe section with auxiliary connections

TECHNICAL FIELD AND BACKGROUND ART

The invention relates to a pipe coupling according to the introductory portion of claim 1 and to a pipe section according to the introductory portion of claim 12. Such a coupling and such a pipe section are disclosed in U.S. patent 3,879,097.

In drilling for hydrocarbons and other subterranean resources, generally a rotary drilling system is used in which a drill string is composed of pipe sections which are successively linked to form a string of stepwise increasing length which is inserted into a bore hole. In as far as the bore hole is in the course of being drilled, the pipe string is lowered gradually into the bore hole as drilling progresses. Furthermore, a drill string has to be removed out of the bore hole and reintroduced into the bore hole several times which involves disconnecting and again connecting pipe sections forming the drill string. Other pipe strings which are being inserted into a bore hole are casing strings lining a bore hole and production pipe strings for transporting fluids to be produced to the earth's surface.

Usually the pipe sections each have a threaded, conical pin at one end and a threaded box of a corresponding shape and size at the opposite end. Subsequent pipe sections are connected to each other by stabbing the pin of a subsequent pipe section into the box of an upper pipe section of a pipe string and screwing the pin into the box with a make up torque. Typically, connecting two pipe sections requires careful positioning of the pin into the box to avoid damage to the threads, 5 to 10 complete rotations of the pin relative to the box and accurate control of the make-up torque which is applied.

A pipe string suspended in a bore hole typically contains a conduit for guiding drilling fluid - often called "mud" - down to a drill bit at a remote end of a drill string or production fluid, such as oil or gas, up from the remote end of a production pipe up to facilities at the surface end of the well.

It is known to provide a drill string with auxiliary transport lines for transporting for instance electronic data signals or electric power for controlling, supporting or enhancing processes at the lower end of the bore hole.

One known way to provide such an electric conductor along a pipe string in a well is to provide an electric conductor in the form of a hard wire in the central conduit of the pipe string. During tripping, such a wire has to be pulled out of each pipe section which is disconnected from the pipe string and threaded through each pipe section to be added to the pipe string. This is cumbersome and laborious and the wire can easily be damaged. Furthermore, the wire extending in the channel of the pipe string causes additional resistance to fluids flowing through that channel.

It is also known to provide one or more cable sections in each pipe section and to connect the cable sections of adjacent pipe sections as the pipe sections are connected to each other. For that purpose, pipe couplings including one or more ring shaped contact members have been proposed for instance in U.S. patents 3,879,097, 4,444,734, 4,095,865, 4,496,203 and 4,537,457.

A disadvantage of such connections is that the space occupied by the contacts reduces the cross section in the coupling available to allow the passage of mud or other fluids. Moreover, the construction of such couplings is complicated. The complexity increases even further with the number of parallel conductors to be integrated in each pipe section.

Another problem of such connections is to maintain the contacts isolated and sealed from mud or other fluids and to

assure that a proper contact is made between the couplings of two coupling members each time a coupling is made up. This is made difficult because, at least before a coupling is made up, the contacts are exposed to adverse conditions and dirt and it is not feasible to have the contacts cleaned each time before the coupling members of two pipe sections constituting a coupling are brought together.

Solutions purporting to overcome these problems have been proposed in U.S. patents 4,220,381 and 4,914,433 in the form of auxiliary connections which do not require a direct contact to be made. However, this approach entails the problem of signal losses at the coupling which has been countered by providing amplification and even power supply from batteries at the couplings.

SUMMARY OF THE INVENTION

It is an object of the invention to reduce the amount of space in a pipe coupling occupied by auxiliary connecting members for connecting auxiliary transport lines of successive pipe sections. It is another object of the invention, to simplify the construction of a pipe coupling including auxiliary connecting members for connecting auxiliary transport lines of successive pipe sections and to facilitate sealing the auxiliary connecting members.

According to one aspect of the present invention, these objects are achieved by providing a pipe coupling according to claim 1. According to another aspect of the invention, these objects are achieved by providing a pipe section according to claim 12.

Since the coupling members include twist limiting abutments cooperating for limiting mutual rotation of the coupling members in make-up sense beyond a predetermined coupled configuration, the orientation of the coupling members relative to each other in the coupled condition is predetermined exactly. Thus, it is assured that, in the coupled condition, the portions of the auxiliary connecting

members intended to communicate - which portions are located exclusively in limited circumferential segments of the coupling members - are located in corresponding positions in circumferential sense so that such communication is reliably assured. Since none of the auxiliary connecting members needs to extend around the axis of the coupling, the cross sectional area occupied by the auxiliary connecting members is substantially reduced, the construction of the coupling members can be simplified and sealing the auxiliary connecting members against mud and other fluids is substantially facilitated due to the reduced length of the seal.

A particular advantage of the reduced cross-sectional area occupied by the auxiliary connecting members is that it becomes feasible to include a large number of transport lines in a pipe string, not only for transporting electric signals and electric power, but also for example for transporting data in the form of light signals along a fiber-optic transport line, for transporting hydraulic or pneumatic power and for transporting gasses and liquids for supporting or enhancing processes in the bore hole along the pipe string.

The foregoing and other objects and features of the present invention are further described in and may be more readily understood from the following detailed description in conjunction with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a view in central longitudinal cross-section of a pipe section according to an embodiment of the invention;

Fig. 2 is an enlarged view in central longitudinal cross-section of one end portion of the pipe section according to Fig. 1;

Fig. 3 is an enlarged view in central longitudinal cross-section of an opposite end portion of the pipe section according to Fig. 1;

Fig. 4 is a side view of the pipe section end portion shown in Fig. 3,;

Fig. 5 is a view according to Fig. 1 of a pipe section according to an alternative embodiment of the invention,

Fig. 6 is an enlarged view in central longitudinal cross-section of a central portion of the pipe section according to Fig. 1;

Fig. 7 is an enlarged view in central longitudinal cross-section of one end portion of the pipe section according to Fig. 5;

Fig. 8 is an enlarged view in central longitudinal cross-section of an opposite end portion of the pipe section according to Fig. 5; and

Fig. 9 is a view in axial cross-section through teeth and abutments of portions of coupling members of yet another embodiment of the invention coupled to each other.

MODES FOR CARRYING OUT THE INVENTION

The coupling shown in Figs. 1-4 is composed of a first coupling member 1 and a second coupling member 51. Both coupling members 1, 51 are provided with an axial bore 11, 61 with opposite open ends. When the coupling members 1, 51 are in connected condition, the bores 11, 61 are in line and define a conduit traversing the coupling. The bores 11, 61 form portions of a central channel 111 of a pipe section 101 of which the coupling members 1, 51 form end portions.

The first coupling member 1 has a base portion 2 and a pin 3 projecting in axial direction from the base portion 2. The other end of the base portion 2 is welded at weld 103 to a tube portion 102 of the pipe section. The coupling member 1 can also be attached to another device of a generally cylindrical or at least elongated shape such as a connecting portion of a tool. At the base of the pin 3, the distal end

of the base portion 2 forms a shoulder 7. On its circumference, the pin 3 is provided with three axially extending columns of thread portions in the form of teeth 4, 5, 6. The number of columns is preferably three as is shown. If the number of columns would be two, this would entail high peak load near the beginning and the end of each tooth. A larger number of slots would generally make the coupling more vulnerable to damage and wear and reduce the angle over which the coupling can be twisted to bring teeth and counter teeth opposite to each other. Nevertheless, in principle other numbers of columns can be provided as well.

The columns 4, 5, 6 are evenly distributed in circumferential sense, leaving open axially extending slots between the columns 4, 5, 6. Two of these slots 9, 10 are visible in Fig. 4. The three columns are identical to each other to balance the loads exerted onto the pin 3 and the box about the central axis thereof and to allow the pin 3 to be inserted into the box in essentially three different orientations. However, it is also possible to provide mutually different columns, for instance to introduce load in axially staggered areas. In this embodiment each one of the columns comprises nine teeth 20-28. In other situations, depending on the load to be transferred and the diameter and material of the coupling, other numbers of teeth may be more suitable. It is noted that, in the present example, the teeth 20-28 of successive columns of teeth 4-6 do not form spaced apart portions of the same thread.

For facilitating production of the coupling members it can however be advantageous to provide that the teeth do form spaced apart portions of the same thread. The coupling members can then for instance be manufactured by first cutting the helical thread and then cutting the axially extending slots.

The second coupling member 51 has a housing 52 of which a proximal end is connected to the tube 102 along a weld 104. The housing 52 has a box 53. On its inner circumference, the box 53 carries three axially extending

columns of teeth 70-78 of which two columns 54 and 55 are visible in Fig. 2. The columns 54, 55 define slots 59 of which the width and the depth corresponds to the width (in circumferential sense) and the height (in radial sense) of the teeth 20-28 of the pin 3. In Fig. 2, only one of these slots 59 is visible.

The distal end surface of the housing 52 forms a sealing surface 57 which is pressed against the shoulder 7 of the first coupling member 1 when the coupling members 1, 51 are in connected condition. The pressure of the sealing surface 57 against the shoulder 7 is obtained by pre-stress generated by mutually engaging teeth 20-28 and 70-78 when the coupling has been made up. In this example the sealing which is obtained is a metal-to-metal seal forming a gastight "premium connection".

The teeth 20-28 of the columns 4, 5, 6 of the pin 3 are arcuately shaped and protrude radially outward from the circumference of the pin 3. Each of the teeth 20-28 has an engagement surface 29 facing away from the free end of the pin 3. In Figs. 3 and 4 only some of the engagement surfaces are designated by a reference numeral. The engagement surfaces 29 are inclined at angles α with respect to a plane 30 perpendicular to the axis of the pin 3. Accordingly, each one of the counter teeth 79 of the box 53 has an engagement surface 79 sloping at the same angle α to a plane perpendicular to the axis of the box 53.

To connect the coupling members 1, 51, first the coupling members 1, 51 are axially aligned, the free (distal) end of the pin 3 facing the open end of the box 53. In rotational sense about the central axis, the pin 3 and the box 53 are aligned such that the columns 4, 5, 6 of teeth 20-28 are in alignment with slots 59 between the columns 54, 55 of teeth 70-78 of the box 53 . It is noted that the orientations of the coupling members 1, 51 shown in Figs. 2 and 3 does not correspond to the alignment before stabbing. The alignment shown in Figs. 2 and 3 according to which the columns 4, 5, 6 of the pin 3 and the columns 54,

55 of the box 53 are aligned with each other would essentially correspond to the rotational alignment in connected condition.

Next, the pin 3 is stabbed into the box 53 until the shoulder 7 at the base of the pin 3 meets the sealing face 57 around the open end of the box 53. It is also possible, to dimension the coupling members 1, 51 such that during stabbing, sloping surfaces of twist limiting protrusions 35, 85 meet each other and cause relative rotation of the coupling members 1, 51 in make up sense to be initiated.

Then, the pin 3 is rotated relative to the box 53, in make up sense (in this example in a clockwise sense), causing, the teeth 20-28 of the pin 3 to engage the counter teeth 70-78 of the box 53. Due to the sloping angles α of the engagement surfaces 29, 79, the pin 3 is pulled into the box 53, completing the make-up of the coupling and causing the surfaces 7 and 57 to be pressed into a sealing contact.

The coupling can be disconnected by applying a torque in the sense opposite to the make-up torque.

Seen in transverse cross-section the teeth 20-28 and counter teeth 70-78 are slightly tapered from the base of the tooth connected to the pin 3 towards the free end. However, various other designs of the teeth and counter teeth, such as for example triangular, curved or sinusoidal cross-sections could be provided as well. The teeth of each column 4, 5, 6 and 54, 55 have mutually different dimensions in accordance with loads transferred through the teeth 20-28 or counter teeth 70-78 in connected condition.

The counter teeth 70-78 on the inner surface of the box 53 have widths, heights, spacings and lengths essentially corresponding to the widths, heights, spacings and lengths of the teeth 20-28 of the pin 3 engaging these teeth when in connected condition, such that the teeth of the pin 3 and the box 53 can engage each other.

If the actual distribution of loads over the teeth is different, or if a less accurate adaptation of the size of the teeth to the loads applied thereto is sufficient, other

distributions of the sizes of the teeth can be selected accordingly. Such a situation occurs for example if, instead of a single seal at the base of the pin 3, a double seal in which the distal end of the pin is pressed in sealing contact with a shoulder in the box is provided. Such a configuration of seals brings about a different axial distribution of loads over the pin and the box and would therefore preferably be combined with a different distribution of the sizes of the teeth. It is observed that, alternatively or in addition, one or more seals can also be located in other positions, such as between the proximal and the distal end of the pin.

When the pin 3 is rotated in make-up sense relative to the box 53, the teeth 20-28 of the pin 3 move into an interleaved configuration with teeth 70-78 of the box 53. The coupling members 1, 51 are each provided with abutment surfaces 35, 85. The abutment surfaces 35, 85 contact each other when the coupling members have reached the coupled condition and limit rotation of the first coupling member 1 relative to the second coupling member 51 in make-up sense beyond a predetermined, coupled configuration.

Because the application of a torque in make-up sense does not lead to the exertion of substantial additional axial loads onto the teeth, the torque applied to the coupling during make-up does not have to be controlled very accurately. This in turn allows to rotate the coupling members very quickly during make up.

The twist limiting abutments 35, 85 ensure that the relative rotational positions of the coupling members 1, 51 in coupled condition is controlled very accurately.

The coupling members 1, 51 are provided with auxiliary connecting members 16, 66. In coupled condition of the coupling, end portions 17, 67 of the auxiliary connecting members 16, 67 communicate with each other. These end portions 17, 67 are each located exclusively in very limited circumferential segments of the coupling members 1, 51 and thereby occupy very little cross-sectional area of the

coupling. In this example, the auxiliary connecting members 16, 66 are formed by conduits extending through protrusions formed by the abutments 35, 85. However, the auxiliary connecting members can also have other forms, such as the form of electric or fiber-optic conductors.

Due to the abutments 35, 85 other than the axially facing sealing surfaces 7, 57, it is ensured reliably that the positions in circumferential sense of the small end portions 17, 67 of the auxiliary connecting members 16, 66 are such, that the end portions 17, 67 of the connecting members communicate with each other when the coupling is in coupled condition. In the present example this is achieved by these end portions 17, 67 being in direct contact with each other. However, it also possible to achieve communication between end portions of the connecting members without actual contact between the connecting members as is described for instance in U.S. patents 4,220,381 and 4,914,433.

Since the area occupied by the end portions 17, 67 of the auxiliary connecting members 16, 66 is very small, it is relatively easy to ensure that the auxiliary connecting members are sealed from the environment when the coupling members 1, 51 are coupled to each other and that any dirt on the auxiliary connecting members 16, 66 is urged away or removed before the auxiliary connecting members 16, 66 are brought together.

Since the auxiliary connecting members 16, 66 do not have to be adapted to cooperate for communication in different circumferential positions relative to each other, the auxiliary connecting members 16, 66 are very suitable for the transport of fluids and optic signals.

The auxiliary connecting members 16, 66 are connected to opposite ends of transport lines 116, 117, 118 and form connections to transport lines of a next successive or previous pipe section when the coupling members of the respective pipe sections are in coupled condition.

Since the thread portions of the coupling members 1, 51 are arranged in a plurality of circumferentially distributed axially extending columns 4-6, 54, 55 defining slots 9, 10, 59 between these columns dimensioned to allow the axial passage of the teeth 20-28, 70-78 of the other coupling member 1, 51, a connection can be made very quickly by stabbing the pin 3 into the box 53 and twisting one of the coupling members 1, 51 over about one sixth of a turn relative to the coupling member toe be connected thereto.

Since during the making up of a coupling, the coupling members 1, 51 are rotated relative to each other over a fraction of a full turn only, different connecting members 16, 66 for different media can be provided in different positions in circumferential sense of the pin 3 and the box 53, as is shown in the present example, while it is avoided that the connecting members 16, 66 pass connecting members for transporting different media when the coupling is made up. Furthermore, since making up the coupling involves rotating the coupling members 1, 51 relative to each other over less than a full turn, the connecting members can be arranged to engage upon twisting relative movement of the coupling members instead of due to axial movement of the coupling members 1, 51 as in conventional couplings. The twisting movement of the connecting members 16, 66 during make up of the coupling covers a larger trajectory than the axial movement. Therefore it can be ensured more reliably that the required communication between the connecting members is established and that dirt and the like does not interfere with communication between the connecting members 16, 66 when the coupling is made up.

To ensure that the portions 17, 67 to be connected of the connecting members 16, 66 can reliably be brought in communicating positions while the coupling members 1, 51 are twisted relative to each other in make up sense until the abutments 35, 85 meet each other, the portions 17, 67 of the auxiliary connecting members 16, 66 communicating in the

coupled condition are carried by protrusions of the coupling members 1, 51.

In the present example, the protrusions carrying the connecting members are obtained in a constructively efficient manner, because the protrusions each form one of the twist limiting abutments 35, 85.

Since the coupling according to the present example has three of the protrusions each carrying one of the portions 17, 67 of the auxiliary connecting members 16, 66 communicating in the coupled condition, the coupling is provided with three auxiliary connections which are reliably separated from each other to avoid interference between signals and/or media transported through these connections. Of course, not all of the protrusions 35, 85 have to be occupied by connecting portions 17, 67 of connecting members, if the number of connections is lower than the number of protrusions 35, 85 on the pin 3 or the box 53. It is also possible to provide that one or more of the protrusions 35, 85 do each carry more than one connecting member. This allows to provide a number of auxiliary connections which is larger than the number of protrusions on the pin 3 or the box 53.

The twist limiting abutments 35, 85 include abutment surfaces 36, 86 facing each other in essentially circumferential sense of the coupling members 1, 51 and being in contact with each other when the coupling members 1, 51 are in the coupled condition, so that the relative rotational position of the coupling members 1, 51 in the coupled condition is controlled particularly accurately and to a large extent independent of the magnitude of the make up torque and torques in make up sense which are transferred by the coupling in operation.

For obtaining a reliable connection, it is further advantageous that the communicating portions 17, 67 of the auxiliary connecting members 16, 66 communicate across the abutment surfaces 36, 86, since it is ensured that these surfaces 36, 86 are in contact with each other when the

coupling has been made up. The contacting abutment surfaces 36, 86 can also serve as a sealing of the connecting members 16, 66 when the coupling is in coupled condition. Another advantage of the connecting members 16, 66 communicating across the abutment surface 36, 86 is that the risk of damaging the connecting members during stabbing is reduced, since contact between the connecting members 16, 66 of the coupling members 1, 51 is made only after the coupling members have been rotated relative to each other in make up sense.

That the coupling members each include more than one pair of the twist limiting abutment surfaces 36, 86 provides the advantage that transverse forces exerted between the contacting pairs of abutment surfaces 36, 86 can cancel each other out and that the loads of the make up torque are distributed over a plurality of abutments. This in turn allows to provide smaller abutments, and thereby more room for the main channel, and brings about a more even distribution of loads over the coupling. Since, in the coupled condition, the auxiliary connecting members 16, 66 communicate across different pairs of the abutment surfaces 36, 86 contacting each other, the different connecting members 16, 66 are reliably separated from each other.

To ensure that only corresponding connecting members 16, 66 are made to communicate with each other when the coupling members 1, 51 are coupled to each other, the coupling members 1, 51 can be formed such that stabbing is possible only if the coupling members 1, 51 are in a predetermined relative orientation about the longitudinal axis thereof.

The portions 17, 67 of the connecting members 16, 66 communicating with each other when the coupling is in the coupled condition face in circumferential sense of the coupling members 1, 51 so that these communicating portions 17, 67 are made to contact when the coupling members 1, 51 are twisted in make up sense. For obtaining a particularly reliable connection, it can also be provided that of a pair

of communicating portions of the connecting members one is inserted into the other or one is made to overlap the other when the coupling members 1, 51 are twisted in make up sense. The abutment surfaces from which connecting members project should preferably be recessed relative to the columns of teeth to avoid that the connecting member can hit the teeth of the other coupling member when the pin of one coupling member is stabbed in the box of the other coupling member.

Since the twist limiting abutments 35, 86 are integrally formed with the pin 3 and the box 53, a particularly strong construction is obtained.

In the present example, the main channel 111 of the tube portion 102 of the pipe section 101 is bounded by a wall consisting of a load bearing tube 105 and a lining 106. The auxiliary transport line sections 116, 117, 118 are embedded in the lining 106 of the wall.

Since the auxiliary transport line sections 116, 117, 118 are embedded in the wall, the flow of fluids through the main channel 111 is not disturbed as in a situation in which the transport line extends freely within the channel and erosion of the wall or the lining of the wall due to unevenness of the wall surface bounding the channel is avoided. Such unevenness occurs for instance if the auxiliary transport lines are covered by a flexible liner as is for instance known from U.S. patent 4,445,734. The advantages of an increased flow and reduced erosion are of particular advantage in conjunction with coupling members including twist limiting abutment members and connecting members having communicating portions in limited circumferential segments of the coupling only, because these features allow to advantageously provide an important number of auxiliary transport lines and to provide auxiliary transport lines of a relatively important cross section without substantially restricting the flow at the couplings. Furthermore, both a low flow resistance and the provision of many auxiliary transport lines are of particular importance

in extended reach drilling (ERD) in which the drill bit is steered by remote control to allow drilling about a bend and in which particularly long drill strings are used.

However, the feature of embedding at least one auxiliary transport line section in a wall of a main channel (or in a layer of that wall) bounded by that wall can also be applied advantageously in combination with conventional couplings of which the coupling members are not provided with twist limiting abutment members (other than the axially facing sealing surfaces) and connecting members on both coupling members which are restricted to limited circumferential segments of the coupling members. In such applications, a less disturbed flow and reduced erosion are achieved as well.

In the present example, the auxiliary transport line sections 116, 117, 118 are embedded in the lining 106. Such a construction can be obtained adding the lining to an existing tube such as a steel tube which can be connected to the coupling members 1, 51 in a conventional manner.

The auxiliary transport line sections 116, 117, 118 extend along the pipe section in the form of a helix, which facilitates embedding the transport lines in the material of the lining and reduces the risk of fracturing of the transport lines in the event of flexing of the tube 102. However, the transport lines can also extend parallel to the longitudinal direction of the pipe string or at a substantially more or less steep angle.

In Figs. 5-8, an alternative, presently most preferred embodiment of a pipe section 301 according to the invention is shown.

In this embodiment, the coupling members 201, 251 have end portions which are in most respects identical to the end portions of the coupling members 1, 51 and therefore not described in detail.

The coupling members 201, 251 are connected to opposite ends of a tube portion 302 having a load bearing wall structure 305 made out of composite material. The

composite material forms an outer sleeve about the socket portions 208, 258 of the coupling members 201, 251. The socket portions 208, 258 have structured circumferences to ensure sufficient adherence of the tube portion 302 to the socket portions 208, 258 of the coupling members 201, 251. It is observed that many other measures for enhancing the connection between composite materials and metal are known and can be applied as well.

The connecting members 216, 266 extend from the portions 217, 267 for communication with other connecting members 266, 216 to the socket portions 208, 258 of the coupling members 201, 251 remote from the ends of the pipe section, where the connecting members 216, 266 are connected to the ends of auxiliary transport line sections 316 terminating at the sockets 208, 258.

The auxiliary transport line section 316 are embedded in the load bearing wall structure of the tube portion 302. This provides the advantage, that a particularly thin wall having integrated auxiliary transport lines 316 can be provided. The auxiliary transport lines 316 are embedded in a helical configuration, which preferably corresponds to the helical configuration of fibers of the composite wall structure which allows to embed the auxiliary transport lines 316 in matrix material of the tube portion 302 with minimal adverse effects on the strength and durability of the tube portion 302.

For some applications it is advantageous if the protrusions carrying the connecting members are not loaded by the torque exerted onto the coupling during make up of the coupling. To this end, the connecting members can be arranged in protrusions separate from the twist limiting abutments. This is schematically illustrated in Fig. 9.

In this embodiment, the coupling members 401, 451 have connecting protrusions 437, 487 carrying the connecting members 416, 466 and connecting portions 417, 467 thereof. These connecting protrusions 437, 487 are separate from protrusions 435, 485 forming the twist limiting abutments.

In coupled condition, when teeth 420, 421 and 470 of the coupling members 401, 451 engage each other and the twist limiting abutments 435, 485 are in contact with each other, the connecting protrusions 437, 487 are positioned such that the portion 467 of one of the connecting members 466, which forms a seal, is slightly compressed between the protrusions 437, 487 so that the connecting members 416, 466 are in sealing contact with each other. If the connecting members are for instance adapted for conducting electric currents, the contacting portions of the connecting members can for instance include flexible contact members instead of or in addition to a seal.

Although the invention has been described in detail with reference to a preferred embodiment, from the foregoing it will readily become apparent to those skilled in the art that many and varied changes can be made without departing from the spirit and scope of the invention. For instance, the transport lines can be embedded in a liner of a tube having a load bearing wall made of composite material.

Claims

1. A pipe coupling for coupling pipe sections (101; 301) for forming a pipe string extending in a subterranean bore hole, comprising: a first coupling member (1; 201; 401) having a pin (3) with a free end and a second coupling member (51; 251; 451) having a box (53) with an open end for coaxially accommodating at least said free end of said pin (3) when in coupled condition; said coupling members (1, 51; 201, 251; 401, 451) including:

thread portions (20-28, 70-78) mutually engaging when said coupling members (1, 51; 201, 251; 401, 451) are in coupled condition and having engagement surfaces (29, 79) sloping in circumferential sense for generating an axial force in response to said coupling members (1, 51; 201, 251; 401, 451) being mutually twisted in a make up sense;

auxiliary connecting members (16, 66; 216, 266; 416, 466) for connecting auxiliary transport line sections (116, 117, 118; 316) terminating at said coupling members (1, 51; 201, 251; 401, 451), said auxiliary connecting members (16, 66; 216, 266; 416, 466) having portions (17, 67; 417, 467) communicating with each other when said coupling members (1, 51; 201, 251; 401, 451) are in said coupled condition;

characterized in that,

said coupling members (1, 51; 201, 251; 401, 451) include twist limiting abutments (35, 85; 435, 485) for limiting mutual rotation of said coupling members (1, 51; 201, 251; 401, 451) in said make-up sense beyond a predetermined coupled configuration; and

said portions (17, 67; 417, 467) of said auxiliary connecting members (16, 66; 216, 266; 416, 466) communicating in said coupled condition being located exclusively in limited circumferential segments of said coupling members (1, 51; 201, 251; 401, 451).

2. A pipe coupling according to claim 1, wherein said thread portions (20-28; 420, 421) of said first coupling member (1; 201; 401) are arranged in a plurality of circumferentially distributed axially extending columns (4-6) defining slots (9, 10) between said columns (4-6);

wherein said thread portions (70-78; 470) of said second coupling member (51; 251; 451) are arranged in a plurality of circumferentially distributed axially extending columns (54, 55) defining slots (59) between said columns (54, 55), said slots (59) between said thread portions (70-78; 470) of said second coupling member (51; 251; 451) being dimensioned to allow axial passage of said thread portions (20-28; 420, 421) of said first coupling member (1; 201; 401) and said thread portions (70-78; 470) of said second coupling member (51; 251; 451) being dimensioned to allow axial passage of said thread portions (70-78; 470) of said second coupling member (51; 251; 451) through said slots (9, 10) between said thread portions (20-28; 420, 421) of said first coupling member (1; 201; 401).

3. A pipe coupling according to claim 1 or 2, wherein at least one of said portions (17, 67; 417, 467) of said auxiliary connecting members (16, 66; 216, 266; 416, 466) communicating in said coupled condition is carried by a protrusion (35, 85; 437, 487) projecting from said first or second coupling member (1, 51; 201, 251; 401, 451).

4. A pipe coupling according to claim 3, wherein at least one pair of said protrusions (35, 85) each form one of said twist limiting abutments.

5. A pipe coupling according to claim 3 or 4, wherein at least one of said coupling members (1, 51; 201, 251; 401, 451) includes a plurality of said protrusions (35, 85; 437, 487), at least two of said plurality of protrusions (35, 85; 437, 487) each carrying at least one of said portions (17, 67; 417, 467) of said auxiliary connecting members (16, 66; 216, 266; 416, 466) communicating in said coupled condition.

6. A pipe coupling according to any one of the preceding claims, wherein said twist limiting abutments (35,

85) include abutment surfaces (36, 86) facing each other in circuferential sense of said coupling members (1, 51; 201, 251) and being in contact with each other when said coupling members (1, 51; 201, 251) are in said coupled condition.

7. A pipe coupling according to claim 6, wherein, in said coupled condition, said communicating portions (17, 67) of said auxiliary connecting members (16, 66; 216, 266) communicate across said abutment surfaces (36, 86).

8. A pipe coupling according to any one of claims 3-7, wherein said protrusions (35, 85; 437, 487) have surfaces (36, 86) facing each other in circumferential sense when said coupling is in coupled condition, and wherein, in said coupled condition, said portions (17, 67; 417, 467) of said auxiliary connecting members (16, 66; 216, 266; 416, 466) communicate across at least two pairs of said surfaces (36, 86) facing each other.

9. A pipe coupling according to claim 7 or 8, wherein said portions (17, 67; 417, 467) of said auxiliary connecting members (16, 66; 216, 266; 416, 466) of said coupling members (1, 51; 201, 251; 401, 451) communicating in said coupled condition have end faces facing in circumferential sense of said coupling members (1, 51; 201, 251; 401, 451).

10. A pipe coupling according to any one of the preceding claims, wherein said twist limiting abutments (35, 85; 435, 485) are integrally formed with said pin (3) or, respectively, said box (53).

11. A pipe coupling according to claim 5, wherein said protrusions (437, 487) carrying said auxiliary connecting members (416, 466) are separate from said protrusions (435, 485) forming said twist limiting abutments, and wherein, in coupled condition, said protrusions (437, 487) carrying said auxiliary connecting members (416, 466) are in co-operating positions for transport between said auxiliary connecting members (416, 466).

12. A pipe section for forming a section of a pipe string extending in a subterranean bore hole, including at

least one auxiliary transport line section (116, 117, 118; 316) extending between opposite ends of said pipe section (101) and two coupling members (1, 51; 201, 251; 401, 451), each at one of said ends, including at least one first coupling member (1; 201; 401) having a pin (3) with a free end or at least one second coupling member (51; 251; 451) having a box (53) with an open end; said coupling members (1, 51; 201, 251; 401, 451) including:

thread portions (20-28, 70-78) for engaging thread portions (20-28, 70-78) of a coupling member of a next pipe section coupled thereto, said thread portions (20-28, 70-78) having engagement surfaces (29, 79) sloping in circumferential sense for generating an axial force in response to said coupling members (1, 51; 201, 251; 401, 451) being mutually twisted in a make up sense;

auxiliary connecting members (16, 66; 216, 266; 416, 466) connecting to opposite ends of said at least one auxiliary transport line section (116, 117, 118; 316), said auxiliary connecting members (16, 66; 216, 266; 416, 466) having portions (17, 67; 417, 467) for communicating with portions (17, 67; 417, 467) of auxiliary connecting members (16, 66; 216, 266; 416, 466) of coupling members of next pipe sections coupled thereto; **characterized in that,**

said coupling members (1, 51; 201, 251; 401, 451) include twist limiting abutments (35, 85; 435, 485) for limiting mutual rotation of each of said coupling members (1, 51; 201, 251; 401, 451) in said make-up sense beyond a predetermined coupled configuration relative to a coupling member (1, 51; 201, 251; 401, 451) of a next pipe section coupled thereto; and

said portions (17, 67; 417, 467) of said auxiliary connecting members (16, 66; 216, 266; 416, 466) for communicating with portions (17, 67; 417, 467) of auxiliary connecting members (16, 66; 216, 266; 416, 466) of coupling members (1, 51; 201, 251; 401, 451) of next pipe sections coupled thereto are each located exclusively in limited circumferential segments of said coupling members (1, 51;

201, 251; 401, 451).

13. A pipe section according to claim 12, further including a main channel (111) bounded by a wall, said at least one auxiliary transport line section (116, 117, 118; 316) being embedded in said wall.

14. A pipe section according to claim 13, said wall including a lining (106), said at least one auxiliary transport line section (116, 117, 118) being embedded in said lining (106).

15. A pipe section according to claim 13, said wall including a load bearing wall structure (305), said at least one auxiliary transport line section (316) being embedded in said load bearing wall structure (305).

16. A pipe section according to claim 15, wherein said load bearing wall structure (305) is made out of a composite material including fibers embedded in a matrix material, said at least one auxiliary transport line section (316) being embedded in said matrix material as well.

17. A pipe section according to any one of the claims 13-16, wherein said at least one auxiliary transport line section (116, 117, 118; 316) extends along said pipe section (101, 301) in the form of a helix.

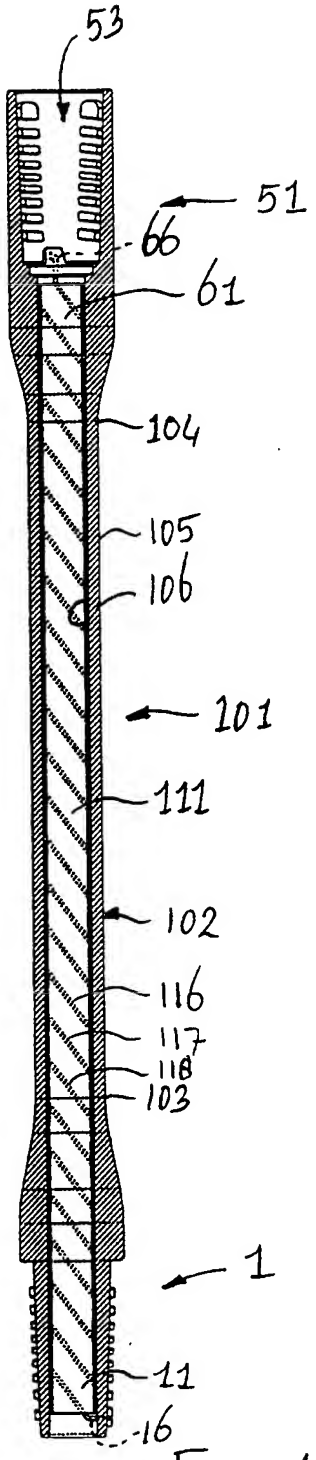

Fig. 1

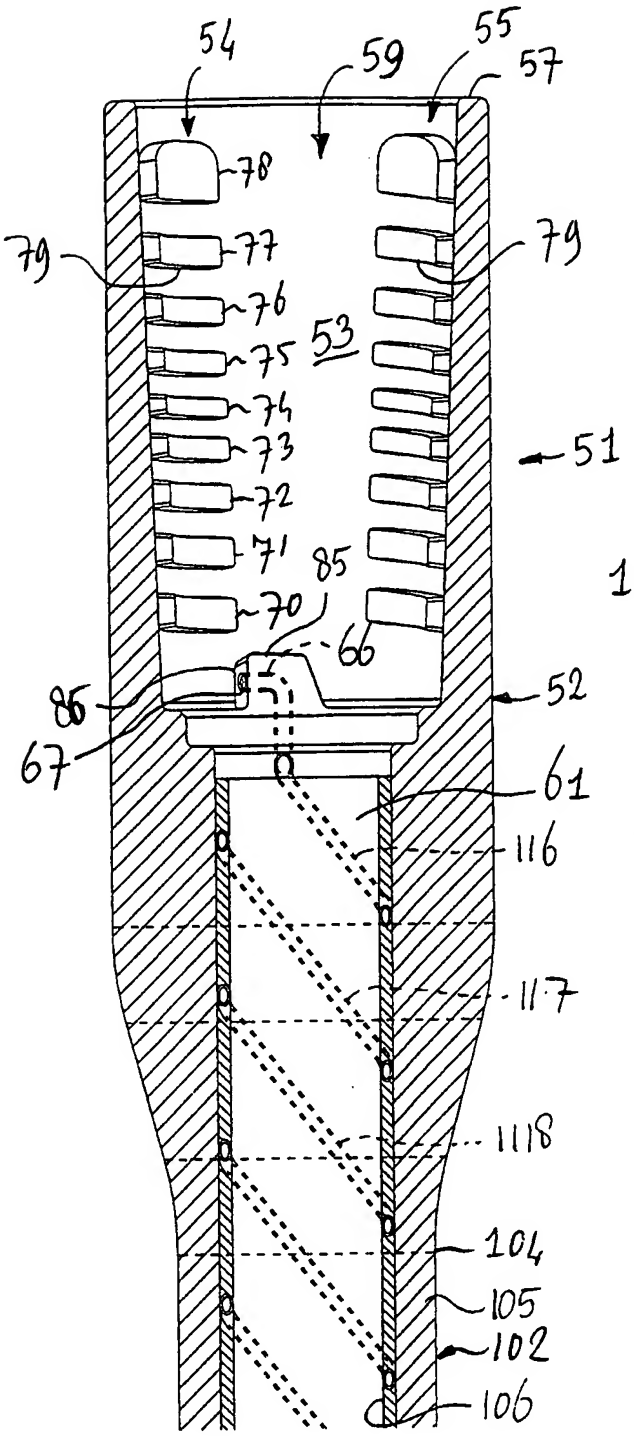
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Fig. 2

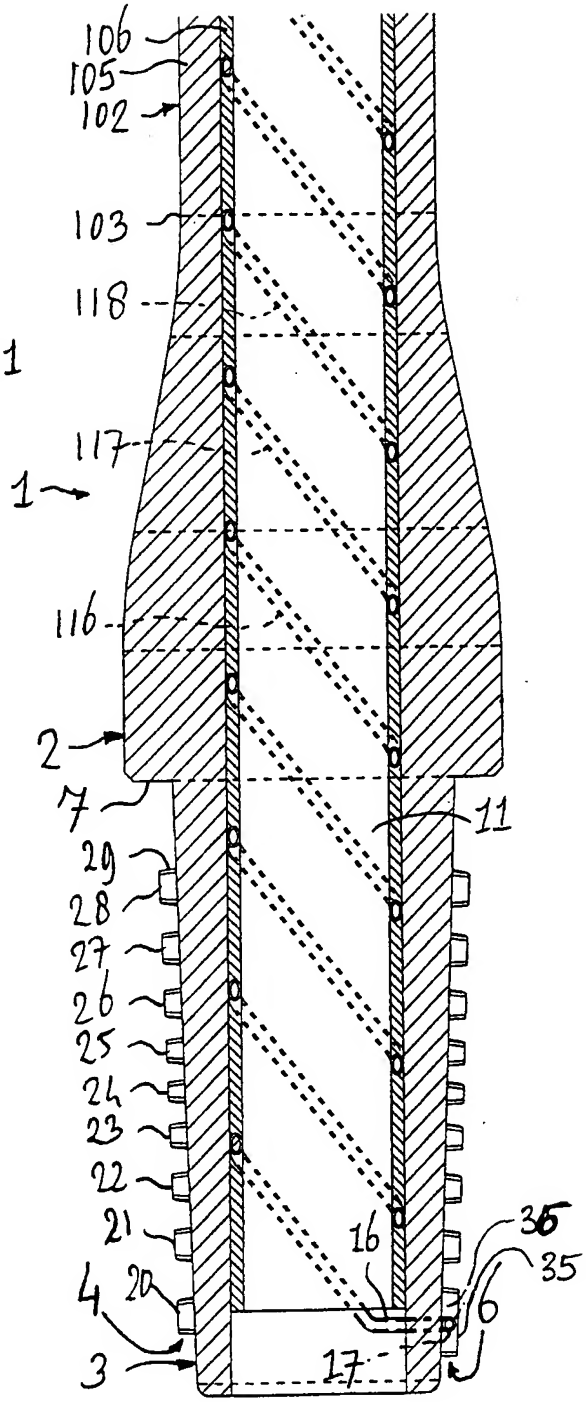
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Fig. 3

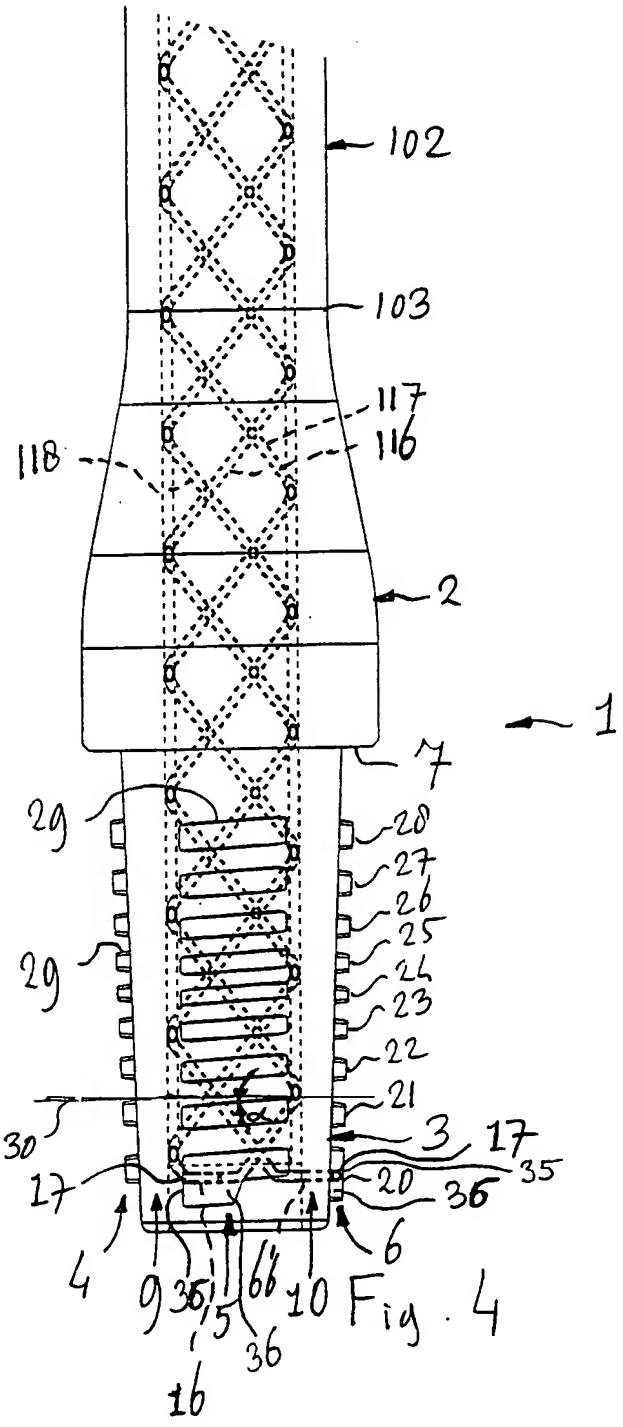
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Fig. 4

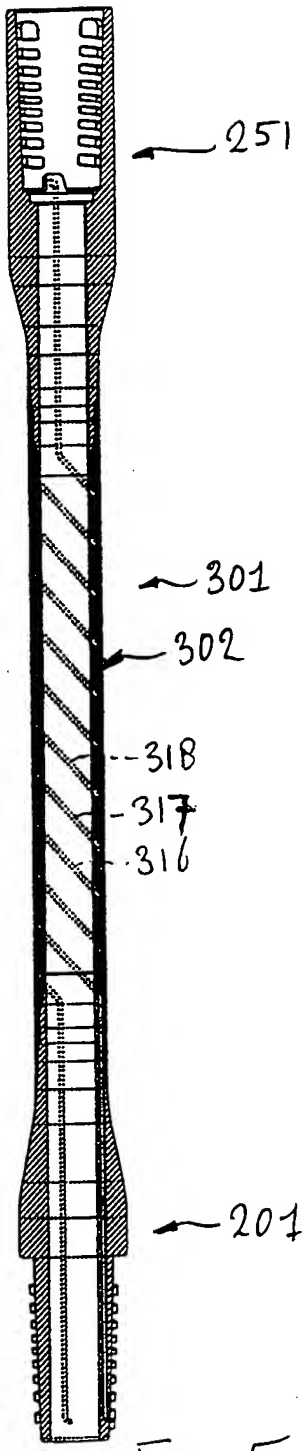

Fig. 5

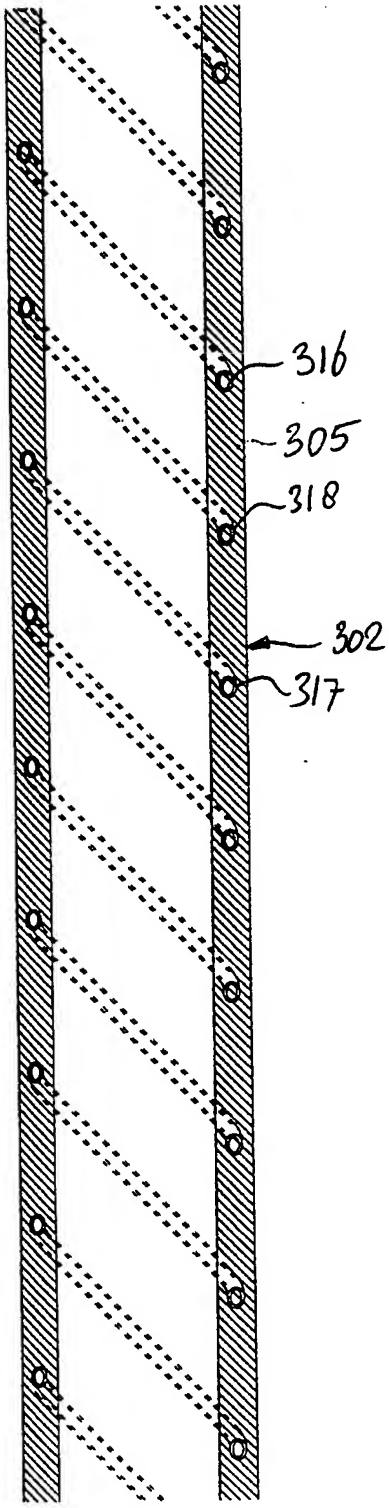

Fig. 6

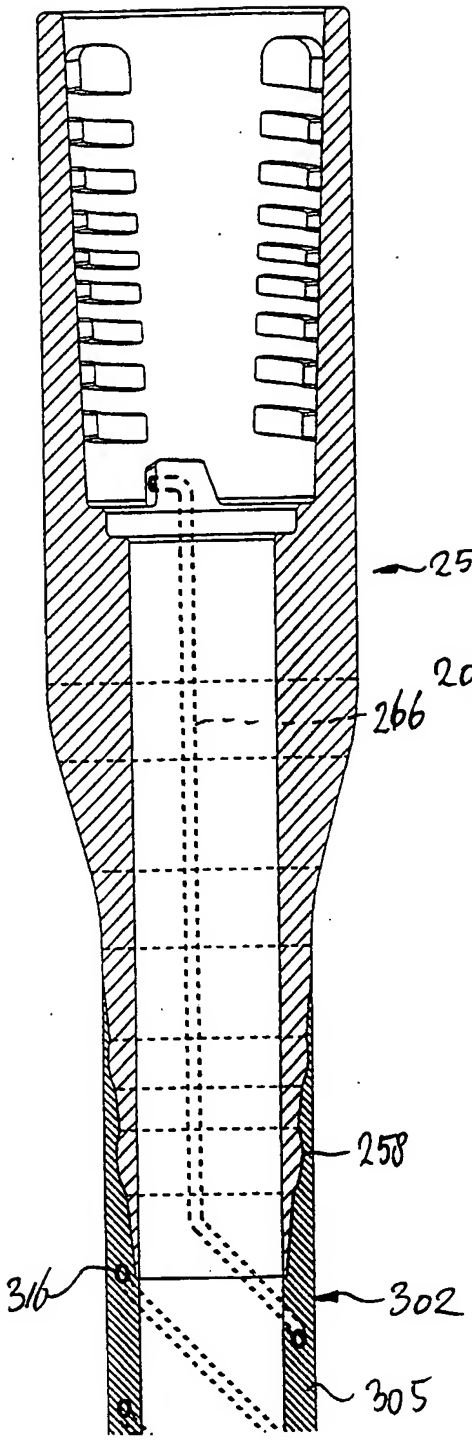

Fig. 7

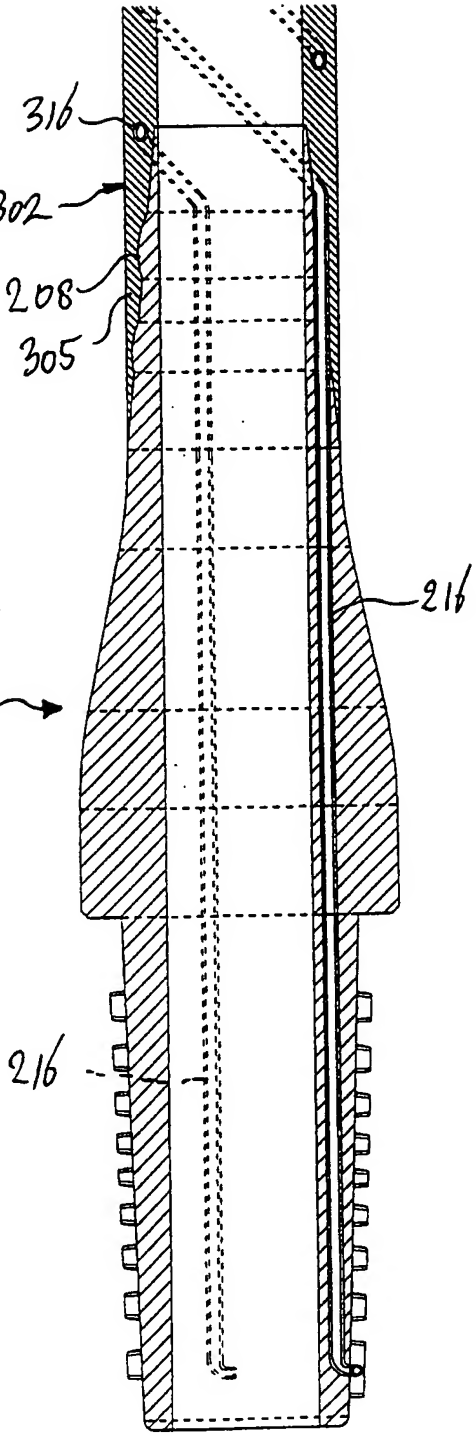

Fig. 8

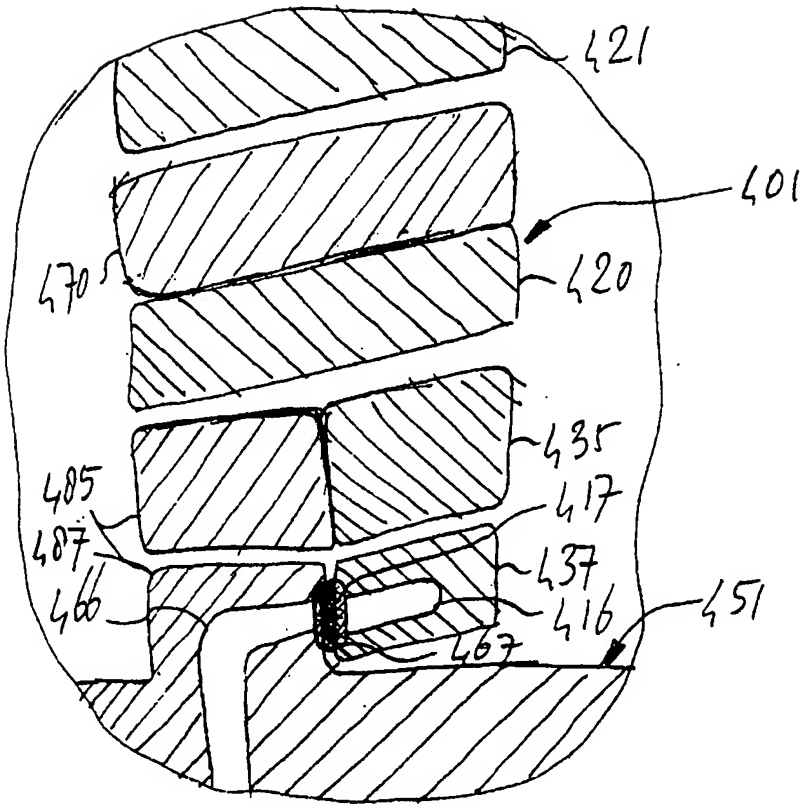

Fig. 9

INTERNATIONAL SEARCH REPORT

Inter tional Application No
PC./NL 99/00158

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 E21B17/00 E21B17/02 E21B17/18

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 E21B H01R

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 2 178 931 A (CRITES, W.J. ET AL.) 7 November 1939 (1939-11-07) page 2, left-hand column, line 58 -right-hand column, line 6; figures 1,3	1,12
A	US 3 879 097 A (OERTLE DON H) 22 April 1975 (1975-04-22) cited in the application	1,12

☐ Further documents are listed in the continuation of box C.

☒ Patent family members are listed in annex.

° Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
11 November 1999	23/11/1999

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL – 2280 HV Rijswijk Tel. (+31–70) 340–2040, Tx. 31 651 epo nl, Fax: (+31–70) 340–3016	Bellingacci, F

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INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No
PCT/NL 99/00158

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 2178931 A	07-11-1939	NONE	
US 3879097 A	22-04-1975	CA 1002992 A	04-01-1977
		DE 2450880 A	31-07-1975
		GB 1463931 A	09-02-1977
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